Chapter 18 Problem 41 [†]

Given

Compression ratio = 8.5
$Ti = 30\ °C$
$\gamma = 1.4$
adiabatic compression

Solution

Find the temperature at maximum compression.

The compression ratio gives us a ratio of the volumes. When the gas-air mixture is entering the engine the volume is a maximum. At maximum compression the volume is a minimum. From this compression ratio we get the relationship

$$V_i = 8.5 V_f$$

Since the process is adiabatic, the relationship between temperature and volume is

$$TV^{\gamma-1} = const.$$

Therefore, the comparison between initial and final volume and temperature is

$$T_i V_i^{\gamma-1} = T_f V_f^{\gamma-1}$$

Solving for the final temperature gives us

$$T_f = \frac{T_i V_i^{\gamma-1}}{V_f^{\gamma-1}} = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1}$$

The temperature used here is an absolute temperature. Therefore, we must convert the temperature to the kelvin scale.

$$T_f = (273 + 30)\left(\frac{8.5 V_f}{V_f}\right)^{1.4-1}$$

$$T_f = 713\ K\ or\ 440\ °C$$

[†]Problem from Essential University Physics, Wolfson